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ABSTRACT

Investigated longitudinally were individual differences in 1- and 2-year-olds' exploratory behavior and their relationship to problem-solving ability. Of particular interest was the stability of exploratory and problem-solving behaviors across the second year of life. It was expected that stability of exploratory behavior would be found in terms of its level in cognitive sophistication rather than in identical behaviors at year 1 and year 2. It was further expected that the variety of different schemes used during exploration at 1 year of age would be related to success and sophistication in problem-solving in the second year. Subjects, from predominantly white and middle-class families, were observed when 26 to 29 months of age in their homes; 15 male and 14 female subjects constituting the longitudinal sample had been observed previously in an infant research laboratory when the children were 1-year-olds. Findings are at least suggestive of some stability of infants' exploration and problem-solving behaviors over the second year of life. As hypothesized, 1-year-old infants who used a greater number of different schemes during exploration were found to be more successful and sophisticated in problem-solving at the age of 2 years. (RH)

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INTRODUCTION

A number of theoretical perspectives on early cognitive and motivational development have for some time recognized that the young child's self-initiated exploration of the environment is an important vehicle for the advancement of cognitive development. Piaget's (1952) pioneering work in this area was followed by White's (1959) theory of competence motivation, Hunt's (1965) intrinsic motivation theory, Lewis and Goldberg's (1969) generalized expectancy model, and Yarrow and his colleagues (1972) mastery motivation concept. These theoretical perspectives led to a redirection and renewed interest in research concerning exploratory behavior during infancy. Recently, research has begun to delineate individual differences in exploratory behavior and relationships between exploration and cognitive competence (Belsky 1980, McCall 1974, Jennings et al 1979). Most of this research has studied cognition in terms of global intelligence measures. However, the developmental implications of individual differences in qualitative aspects of exploration, in terms of both longitudinal stability and relations to specific features of cognitive functioning, has received relatively little attention. The present investigation

focused on individual differences in specific qualitative aspects of exploratory behavior, defined in terms of cognitive sophistication, and their relationship to problem-solving ability. Using data from infants who participated at both one and two years of age, longitudinal questions concerning the stability of exploratory and problem-solving behavior across the second year of life were addressed.

Two specific hypotheses concerning the longitudinal questions were addressed in the study. First, it was expected that stability of exploratory behavior would be found in terms of its level in cognitive sophsitication rather than in identical behaviors at two ages. Since sophsiticated exploring consists of different behaviors at age one and two, this hypothesis implies finding correlations between these different aspects of exploring and no correlations between identical behaviors. Second, it was expected that the variety of different schemes used during exploration at one year of age would be related to success and sophistication in problem-solving at age two. This hypothesis was based on Piaget's analysis of sensorimotor intelligence. He suggested that the onset of new cognitive abilities at 10 - 12 months of age was based on the infant's ability to differentiate and recombine behavioral schemes in new ways. In the present investigation, therefore, it was hypothesized that more different schemes in an infants behavioral repertoire at 12 months should provide more opportunity for their creative and insightful combination and lead to enhanced problem-solving ability later in life.

SUBJECTS

Forty infants (22 male and 18 female) and their parents were observed in their homes when the children were 26 to 29 months of age. Twenty-nine of these infants (15 male and 14 female) had participated in a related earlier study at one year of age and constituted the longitudinal sample. The subjects were fron predominantly white, middle-class families from a small college town and the surrounding rural areas.

METHOD

Data for the two-year old phase of the study were collected during a visit to each child's home by the investigator and an assistant who served as an observer. The data collection procedure was similar to that developed by Belsky (1980) and was designed to enhance the ecological validity of the behavior observed by simulating the common occurance of a visitor talking with the parent while the child plays nearby.

During the home visits, the child's behavior on four tasks, two exploratory and two problem-solving, was observed and recorded by the assistant while the investigator presented the task materials to the child. After a suitable warm-up period, task behavior was recorded using predetermined behavior checklists on a continuous 10-second interval basis. The materials for the exploratory tasks consisted of a number of objects and toys presented to the child for open exploration.

The problem-solving tasks required the child to retrieve a toy from behind a clear, plexiglass barier. Each of the four tasks was timed to last no longer than 5 minutes. If a child lost interest before the end of 5 minutes on a given task, the investigator attempted twice to regain interest using encouraging verbal statements. The task was considered over if lack of interest persisted after these two prompts.

Data collection for the one-year-old period took place in a university "infant research lab." In order to address the longitudinal questions, the research procedures, behavior recording method, and task materials were identical to those used at two years of age except that some task materials were changed to be appropriate for younger infants.

Inter-rater reliability of the behavior recording system was assessed prior to and during the research. Percentages of agreement between two coders on all behaviors were calculated and the results were between .65 and 1.00 with a mean of .83.

A number of measures for both exploratory and problem-solving behavior were derived from the behavior checklists. The score for each variable was calculated based on totals for both tasks, since the purpose in using two tasks was to provide each infant a variety of opportunities to use their full behavioral repertoire. Exploratory variables included the amount of different exploratory behaviors used such as fine and gross motor, mouthing, combining, sequencing, pretending, and so forth, the number of different schemes used to explore, the amount of

indepth exploring, and several measures of the quantity of exploration engaged in. Variables for problem-solving were perisitence, number of different strategies used, success in solving a task, and cognitive sophistication of problem-solving behavior.

RESULTS

The major research objectives of the study were addressed using bivariate correlational analyses. Subgroup differences based on gender, birth order, and age were also examined. Since only a few subgroup differences were found in over 40 tests, all analyses reported here were computed for the sample as a whole. In order to provide an overall picture of individual differences in exploratory behavior, descriptive statistics will be presented first. This will be followed by the longitudinal findings which include both the stability of individual differences and the relationship between early exploring and later problem-solving ability.

Individual Differences in Exploratory Behavior

Means, standard deviations, and ranges for all exploratory and problem-solving measures are presented in Table 1 for one-year-olds and Table 2 for two-year-olds. By examining these tables it can be seen that a wide range of individual differences was found on all measures of exploratory and problem-solving behavior. For example, the ratios between high and low scores

for most variables exceeds 3 to 1. The scores for different types of exploratory behaviors ranged from near zero to 30 or 40 for each.

INSERT TABLE 1 AND

TABLE 2 HERE

Longitudinal Relationships

The longitudinal questions of the study were addressed based on the sample of 29 infants who were followed up at two years of age. The longitudinal correlations are presented in Table 3. It is important to note several features of this aspect of the study when examining this table. First, all measures that were used at both ages were similarly operationally defined and were recorded in the same way. They therefore are equivalent measures at the two ages. However, several measures were used only at age one or age two because they are not applicable at the other age for either conceptual or behavioral reasons.

The first longitudinal question concerned the stability of individual differences in exploratory behavior across the second year of life. As can be seen in Table 3, direct correlations between identical aspects of behavior, were not found. For example, the amounts of visual, combining, fine motor, or gross

motor exploring engaged in at one year of age were not related to the amounts of these behaviors used at age two. However a pattern of relationships does support the hypothesis that there is some stability between ages one and two in terms of the sophistication of the exploratory and problem-solving behaviors used. This pattern is based on positive correlations found between behaviors considered sophisticated at each age and negative correlations between more and less sophisticated behaviors. For example, fine motor exploring at one year was considered highly sophisticated whereas undifferentiated gross motor behaviors used to explore were viewed as an unsophisticated approach to exploration at that age. It was found that the use of more fine motor exploration at one year was related to more sequencing, a highly sophisticated exploratory behavior, at two years of age ($r=.40$) while gross motor exploring at age one was negatively correlated with sequencing at two years ($r = -.49$). Additionally, the number of unsophisticated schemes used to explore at one was also negatively related to sequencing at two years ($r = -.51$).

INSERT TABLE 3 HERE

A number of other relationships which support this pattern in the data can be noted in Table 3. Relationships between

sophisticated early behaviors and later sophisticated exploring or problem-solving include combining at one with persistence at two years (r = .48) and use of more strategies in problem-solving at one year with more sequencing and fine motor exploring at two years (r = .43 and .52 respectively). There were also positive correlations between less sophisticated aspects of behavior across the second year such as more alterations per scheme at one with unsophisticated gross motor exploring at two years (r = .39). Some stability was also found between early and later problem-solving ability, though the correlations only approached significance. Infants who were able to solve a task at one year were found to be more successful (r = .36) and sophisticated (r = .29) in problem-solving at age two.

While this pattern of relationships does provide evidence for stability over a broad range of behaviors, it is important to consider the issue of multiple comparisons when interpreting this data. As can be seen in the table, only about as many significant correlations were found as might be expected by chance. However, the lack of correlations between identical index behaviors actually supports the hypothesis that stability would be found only in terms of the cognitive sophistication of behavior. Also, since support for stability over the second year is based on a general pattern of relationships rather than on only one or two specific correlations, the possibility of a chance finding is reduced. However, since a number of relationships that would be consistent with this pattern were not found, these findings are considered only suggestive.

The second major longitudinal question concerned the relationship between early exploratory behavior and later problem-solving ability. In addressing this issue, a whole range of relationships between qualitative and quantitative aspects of exploratory behavior at one year and problem-solving at age two were examined. The findings regarding this question are particularly interesting, especially in light of the contemporaneous relationship found in the one-year-old sample. At one year of age, the only aspect of exploratory behavior that was related to problem-solving ability was the number of different schemes used to explore. One-year-olds' who used more different schemes during exploration were more successful ($r = .31$) and sophisticated ($r = .35$) in problem-solving.

As can be seen in Table 3, the longitudinal relationships found offer clear support for the hypothesis in the present study. The number of schemes used to explore at one year was positively correlated with both success ($r = .40$) and cognitive sophistication ($r = .40$) in problem-solving at two years of age. Furthermore, no other aspect of early exploratory behavior was related to later problem-solving ability. This finding directly parallels the contemporaneous relationship found in the one-year-old sample. In other words, the number of different behaviors used to explore is related to problem-solving ability rather than the amount of any given behavior regardless of its degree of sophistication.

DISCUSSION

There were two major questions addressed in this longitudinal study. The first concerned the stability of individual differences in exploratory behavior across the second year of life and the second the relationship between early exploratory behavior and later problem-solving ability.

With regard to the first question, it was expected that stability would be found in terms of the quality of behavior rather than with identical behaviors at two ages. The data provide some support for this hypothesis, however, because only a few relationships were found, they were interpreted as only suggestive. One feature of the data that supports the hypothesis strongly is the finding of no longitudinal relationships between identical aspects of behavior. Infants who engaged in more gross motor exploring at one year were not found to use more gross motor behaviors to explore at two years, and so forth. Longitudinal relationships were found only between behaviors considered more or less sophisticated at the two ages. On a range of behaviors, one-year-olds' who engaged in more sophisticated exploring and problem-solving were found to use more sophsiticated behaviors and fewer unsophisticated behaviors at two years of age.

In general, then, these results are interpreted to be at least suggestive of the finding that there is some stability over the second year of life in terms of the cognitive sophistication of the behaviors infants use in exploration and problem-solving.

Also, it is important to note that this finding is based on a pattern of relationships among a broad range of more and less sophisticated behaviors. This approach differs from previous studies which have characterized sophistication in exploring in terms of specific index behaviors. However, further investigation of this issue is clearly warranted, especially given the sugestive nature of the results of this study and the paucity of previous research addressing the issue of stability in early behavioral competence.

The second longitudinal question addressed in the study concerned the relationship between exploratory behavior at one year and problem-solving ability at two. As hypothesized, one-year-old infants who used more different schemes during exploration were found to be more successful and sophsiticated in problem-solving at two years of age. While this relationship parallels that found contemporaneously in the one-year-old sample, the longitudinal correlations are even stronger. Figure 1, below, clearly represents this pattern of relationships. As can be seen in this figure, the relationship between early exploring and later problem-solving is stronger than both the contemporaneous correlation and the relationship of problem-solving at one to problem-solving at two years.

INSERT FIGURE 1 HERE

Since no other aspect of exploration either contemporaneously or longitudinally, was found to be associated with problem-solving ability, this finding clearly supports the idea that the variety of different behaviors infants use to explore at one year is important for problem-solving rather than the amount of any given behavior, regardless of its degree of sophistication.

This finding both refines, and extends the results reported in a number of previous studies concerning the relationship between early exploratory behavior and later cognitive functioning. For example, exploratory behavior in infancy was found to be related to 3 1/2 year IQ scores by Yarrow and his colleagues (1972, 1972) and to later imitation and verbal skills by McCall, Hogarty, and Hurlburt (1972). Also, Kagan (1971) reported a relationship between slow tempo exploration and cognitive sophsitication on an embedded figures task at 27 months.

Since the present investigation examines a more specific cognitive ability than IQ or verbal skills, it significantly refines our understanding of these relationships. The problem-solving tasks used here required anticipation and insight to solve without trial and error. Therefore, this specific ability was found to be associated with the variety of different behaviors or schemes one-year-olds' use to explore. This finding also extends Kagan's earlier work concerning behavioral tempo. In the present study, one-year-olds' exploratory tempo when using sophisticated schemes was found to be slower than with

unsophisticated schemes and the use of more sophisticated schemes correlated positively with two year problem-solving. However, no direct correlation was found between behavioral tempo and later problem-solving demonstrating that it was not simply the slower tempo, but rather the number of different schemes used, that predicted later success and sophistication in problem-solving. In other words, it is the quality of behavior in terms of the number of different schemes used, rather than behavioral tempo, that is important in predicting problem-solving ability in the present study.

A number of conclusions can be drawn from the findings of the present study. First, it is evident that individual differences in qualitative aspects of exploratory behavior can be measured during the ongoing stream of behavior in a naturalistic setting. Also some aspects of exploratory behavior have important developmental implications and qualitative features of exploring seem to be more important than quantative aspects in this respect. In terms of conceptualizing future studies of early behavioral abilities, it is particularly important to note the finding here that stability across the second year of life was found in terms of the quality of behavior rather than in specific index behaviors. In general, the findings of this study stress the importance of continuing to develop more fine grained and differentiated approaches to studying the evolution of early behavioral abilities in naturalistic settings since individual differences in these areas may have significant developmental implications.

References

Belsky, J., Goode, M., & Most, R. (1980). Maternal stimulation and infant exploratory competence: cross sectional, correlational, and experimental analyses. Child Development, 51, 1163-1178.

Hunt, J. (1965). Intrinsic motivation and its role in psychological development. Nebraska symposium on motivation, 13, 189-282.

Jennings, K., Harmon, R., Morgan, G., & Yarrow, L. (1979). Exploratory play as an index of mastery motivation: relationships to persistence, cognitive functioning, and environmental measures. Developmental Psychology, 15, 286-394.

Kagan, J. (1971). Change and continuity in infancy. New York, Wiley.

Lewis, M. & Goldberg, S. (1969). Perceptual-cognitive development in infancy, a generalized expectancy model as a function of mother-infant interaction. Merrill-Palmer Quarterly, 15, 81-100.

McCall, R. (1974). Exploratory manipulation and play in the human infant. Monographs of the Sociaty for Research in Child Development. (Vol. 39), 2.

McCall, R., Hogarty, P., & Hurlburt, N. (1972). Transitions in infant sensorimotor development and the prediction of childhood IQ. American Psychologist, 27, 728-748.

Piaget, J. (1952). The origins of intelligence in children. New York: International University Press.

White, R. W. (1959). Motivation reconsidered: the concept of competence. Psychological Review, 66, 297-333.

Yarrow, L., Rubenstein, J., Pedersen, F., & Jankowski, J. (1972). Dimensions od early stimulation and their differential effects on infant development. Merrill-Palmer Quarterly, 18, 205-218.

Yarrow, L., Rubenstein, J., & Pedersen, F. (1975). Infant and environment: early cognitive and motivational development. Washington, DC: Hemisphere.

TABLE 1

One Year
Descriptive Statistics

	Mean	Standard Deviation	Range
Exploratory Behavior			
Schemes Used	6.88	1.36	4.0 - 9.0
Alterations Per Scheme	4.59	0.84	2.9 - 6.5
Percent Time Exploring	0.93	0.07	.74 - 1.00
Total Exploratory Acts	61.4	11.9	32 - 89
Behavioral Tempo	1.42	0.24	0.86 - 1.89
Visual Examination	21.5	8.2	4 - 37
Fine Motor	11.5	7.8	1 - 33
Gross Motor	17.7	11.2	0 - 49
Mouthing	8.5	6.1	0 - 20
Combining	2.4	2.9	0 - 11
Problem-Solving			
Persistence	6.8	5.0	1 - 18
Strategies	4.6	3.5	0 - 15
Solve-Scale	1.9	1.1	0 - 4

TABLE 2

Descriptive Stastics (n=40) - Two Year

	Mean Both Tasks	Standard Deviation	Range
	Exploratory Behavior		
Sequencing	4.1	5.4	0 - 23
Pretending	3.5	3.8	0 - 15
Combining	10.5	7.3	0 - 30
Manipulated to Look	25.0	5.8	13 - 38
Fine Motor	9.5	5.5	2 - 24
Diversity	10.6	1.8	6 - 14
Indepth Exploring	7.3	6.7	0 - 28
Gross Motor	6.6	4.9	0 - 22
Questions	7.0	8.0	0 - 25
Visual Examination	6.4	3.7	1 - 16
Summary Sophisticated	31.8	14.3	12 - 66
Total Exploratory Acts	66.7	19.0	36 - 113
Percent Exploring	0.96	0.04	0.86 - 1.00
Quantity Summary	142.4	23.9	103 - 196
	Problem-Solving		
Visual Examination	6.8	4.1	1 - 17
Total Time Problem-Solving	28.7	9.5	14 - 60
Persistence	32.7	10.8	18 - 72
Strategies	9.3	4.2	2 - 19
Solve-Scale	2.4	1.4	0 - 4

Table 3

Longitudinal Relationships (N=29)

One Year	Two Year: Sequencing	Pretending	Combining	Manip /Look	Fine Motor	Diversity	In-depth	Gross Motor	Questions	Visual Exam.	Summary Soph.	Summary Quan.	Persistence	Strategies	Solve Group	Solve Scale
Number of Schemes	--	--	--	--	--	--	--	--	--	-.45**	--	-.39**	--	--	.40**	.40**
Sophis. Schemes	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.40**	.46**
Unsophis. Schemes	-.51*	--	--	--	--	--	--	--	--	-.46**	--	-.38**	--	--	--	--
Alterations per scheme	--	--	--	--	--	--	--	.39**	--	--	--	--	--	--	--	--
Visual Exam.	--	--	--	--	--	-.39**	--	--	--	--	--	--	--	--	--	--
Fine Motor	.40**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Gross Motor	-.49**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mouthing	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Combining	--	--	--	--	--	--	--	--	--	--	--	--	.48**	--	--	--
Total Expl. Acts	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Behavioral Tempo	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Persistence+	--	--	--	--	--	--	--	-.39	--	--	--	--	-.38	--	--	--
Strategies+	.43**	--	--	--	--	.38	--	--	--	--	--	--	--	--	--	--
Solve Group	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.32	.35
Solve Scale	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

* = ≤ .01
** = ≤ .05
= ≤ .10

\+ = N = 24 for these variables since children who solve tasks quickly do not receive a score.

Figure 1

RELATIONSHIP BETWEEN NUMBER OF SCHEMES USED TO EXPLORE AT ONE YEAR AND PROBLEM-SOLVING AT ONE AND TWO